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ABSTRACT

The first year's activities of the Massachusetts Institute of Technology (MIT) Research Program on Communication Policy are described. Among the projects undertaken were studies of: (1) land mobile radio systems, (2) direct satellite broadcasting in foreign countries, (3) communications regulation policy, (4) international data communication, and (5) pay television for the performing arts. The program has also promoted interchange through seminars and publications involving specialists who approach communication policy from differing perspectives. A description of cognate activities, including publications, and a listing of the program's personnel are also provided. (Author/DGC)

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# MIT
# Research Program
# on
# Communications Policy

## FIRST ANNUAL REPORT

A joint project in
The Center for Policy Alternatives
The Center for Advanced Engineering Study
The Center for International Studies
The Electronic Systems Laboratory

supported by
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The Markle Foundation

Massachusetts Institute of Technology
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December, 1974

PROGRESS

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## INTRODUCTORY COMMENTS

MIT's Research Program on Communications Policy has grown rapidly, as have a number of others around the country. One might ask what has caused this wave of interest in communications policy, not only in the United States, but also abroad. Perhaps we should briefly consider the developments that have placed communications policy so high on society's agenda.

Any organized society will have communications policies, be they established deliberately or not. The American Constitution embodies communications policies accepted by the Founding Fathers. Section 8 of Article 1 gives to Congress the power to establish post offices and post roads, an important stimulus to the media of the day. The next clause of the same Article gives to Congress the power "To promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries." Under the First Amendment the Congress was prohibited from passing any law "abridging the freedom of speech, or of the press." The public policy of the day was clearly to promote the development of independent journalism and publishing. The government was to provide certain facilities that the media needed for their operation and growth, and was simultaneously restricted from interfering with their free expression.

In the comparatively simple society of the 18th Century, when the media depended largely on the stable technology of the printing press and government consisted of the relatively spare mechanisms of courts, Congress, and a tiny Executive branch, the policy issues were few. A government could conceivably have used its coercive legal powers against the press, so the First Amendment prohibited that. A government could also have used its fiscal powers both against and for the benefit of the press. The experience of the British stamp tax on documents was well within the memories of the American people, and anything resembling that measure would have aroused protest. Supportive use of fiscal powers, however, was not opposed; besides providing post offices and post roads, the Federal government supported the press through official advertising and occasionally by means of sinecure appointments. The idea that government should stand at arm's length from the press developed later. The earliest Federal policy was to actively foster and sustain the media.

That was 200 years ago. Twenty years ago the situation had become far more complex, but was still simple compared to the present. The press, which at the founding of the nation had consisted mostly of one-sheet papers which often went bankrupt after a few issues, had come to consist of large and stable institutions, each typically a monopoly in its own city. More important, an array of new electronic media had come into existence alongside

the print media, bringing with it complex new policy issues. The electromagnetic spectrum was a limited resource allocated by the government. Electronic impulses transmitted over wires also had public policy implications; the franchise to run wires through a community was usually given as an exclusive privilege. And so for both print media and electronic media, policy issues arose as to what to do about the tendency toward monopoly, how strictly to apply antitrust law to newspapers was one issue. The establishment of the Federal Radio Commission in 1927 and the Federal Communications Commission in 1934 were attempts to deal with the problems of natural monopoly in the electronic communications field in the same regulatory mode that had been devised for transportation and power.

In 1970 the establishment of the Office of Telecommunications Policy reflected a recognition (previously expressed in the Rostow Report prepared for President Johnson) that the vastly enlarged federal government impinged on the communications system in other ways than as a regulator of monopolistic practices. For example, the federal government occupies about half of the available spectrum and is also a major factor in the development of new technologies.

Complex and important as issues of communications policy may have been in the recent past, a look at the horizon indicates that they will become massively more complex and important. Up to now the older print media have been affected, but not themselves transformed, by the new electronic media. As the latter passed from infancy to adolescence, they enlarged their field of action, but left the older media fundamentally what they had been before. That is not likely to continue to be the case. The distinctions between the various modes of message delivery are vanishing. Newspapers, for example, get much of their news by wire, rely on computers for composition, and in the future may deliver some of their text by facsimile or data communications. Young reporters in some newsrooms today no longer type on paper; they are working at computerized CRTs. With the recent favorable printers' union settlement at the New York Times, this transformation will doubtless move rapidly throughout the industry. The Times has also entered the data base publishing business, a business that is already at $100,000,000 nationally and growing at about 20% per annum. And, of course, the pressures for cross-ownership between media are powerful.

With the increasing use of telecommunications in publishing, the problems of the electronic media become problems of the media system in general. No longer can one view electronic communications as a circumscribed special case whose monopolistic and regulated elements do not matter very much, because the larger realm of freedom of expression still encompasses the print media. The issues of telecommunications policy are becoming the issues of all communications policy as all communications become susceptible to electronic forms of transmission.

What is taking place is something that is usually described as the "convergence of the media". That is to say, separate services formerly delivered on quite different media are now becoming available on new multiservice media with impressive ranges of capabilities. Coaxial cables (and ultimately, perhaps, optical fibers) can deliver sufficient bandwidth to the home or office not only to carry a score of CATV channels, but also to provide voice telephone circuits, and at the same time, perhaps, funds transfers, teletyped messages, and security or environmental monitoring. The economics of communications satellites suggest that special-purpose communications satellites are less likely to predominate in the heavens than more versatile multipurpose alternatives. Computer networks are turning out to be convenient message delivery systems. Ways are being found to send pay entertainment not only over CATV, but also in mailed cassettes, over telephone lines, and also over the air. The competition among the modes becomes more intense and they become harder to distinguish from one another.

Along with the increasing convergence among modes which used to have quite distinct delivery technologies, another development that changes the regulatory picture is the vast increase in message capacity. Cable may make possible a "television of abundance", with scores of channels available for servicing every small group in the same way that specialized magazines do today. We will be surprised if by 1995 the economical way to keep files is not in computer memories, or if millions of homes are not equipped with computer-controlled multimode terminals that can deliver education and other personal services into the residence. But if economical capacity for communications delivery is growing rapidly, demand in many cases is rising even faster. The telephone system has not always been able to keep up with demand. The demand for land mobile radio spectrum exceeds what is presently available for many user categories. The bottlenecks are varied, and they are not always scarcity of spectrum; there may be TV channels available but no good programming to put on them. In any case, the notion that electronic communications is the realm of natural monopoly and print the realm of abundance and freedom is clearly obsolete.

A third new development with profound ramifications is the demise of distance as a major component in communications costs; some observers speak of distance-insensitive rates. In this satellite era, the cost of a text message or phone call is only trivially different for 6000 miles and 600 miles. The costs beyond the local delivery loop are for the long lines switching system, accounting, and billing, but only insignificantly for transmission. Dominant over distance as a factor in costs are traffic volume, peaked demand, and the like.

The implications of that fact for the structure of human contacts are profound. We may be entering an era in which professional colleagues interact according to specialty with little concern

for their physical location. The best and most attractive video program materials, wherever they may be produced, may enter a highly fluid world market with few natural barriers -- language being the most important one and time zone another. It is not clear, however, that the world is ready to accept such a free flow of messages. In the last few years the prospects of satellite broadcasting and the international spread of TV have become highly sensitive issues in many countries and in the major world organizations.

We are thus entering an era in which the implications of communications policy will be increasingly international. Developing countries must consider how communications can contribute to their development. Developed countries face the same problems of communications policy as we do in the USA, though their solutions may be quite different. For example, most have responded to the problem of natural monopoly by nationalization. Each is today asking what to do about new communications technologies such as CATV and satellites, the changes in the role of the different modes of communication that result, how to take advantage of the potential abundance of bandwidth, and the impact of all these developments on existing communications institutions.

Both because of the increasing flow of communications across national borders and because of the similarity of the problems in different countries, it is important to look at current problems of communications policy in a comparative and international perspective. American students of communications rarely do this; they tend to keep their attention focused on the FCC, the Supreme Court, the television networks or other American media. We at MIT have tried to maintain a broad perspective and to develop a program of co-operative research with colleagues abroad. In the report below we describe some first efforts to develop such relations.

In short, then, we find that all advanced industrial countries face more difficult communications policy issues than ever before. The issues are not only more complex, due to the new technologies; the issues are also more <u>serious</u> because for the first time telecommunications has become inextricably enmeshed with the traditional print modes of communication. Nor can the electronic media any longer be regarded as merely supplements to print and face-to-face communication. Increasingly television has become the main news medium in the United States, much as radio is in many developing countries. Electronic media of such complexity that they invite regulatory controls are becoming in many instances the carriers of our political and cultural life.

With the rise of computer-controlled media has also come a growing fear of the abuses of which such powerful devices are capable. Invasion of privacy, continuous monitoring of behavior, and control of information flows may become easier.

These are some of the reasons why centers for study of communications policy are springing up in many places, and also why the development of the MIT Research Program has struck such a responsive chord among faculty and students alike. MIT has a unique concentration of expertise in many of the technologies that are revolutionizing contemporary communications. It has thus proven a highly favorable environment in which to raise the political, social, and economic questions that these new technologies pose. We have been most fortunate in gaining the interest of a co-operative group of faculty and graduate students with a broad range of talents in both the natural and social sciences. Both of these need to be brought to bear if we are to take full advantage of the opportunities while avoiding the dangers which the new communications technologies make possible.

- Ithiel de Sola Pool

SUMMARY

This is a report to the National Science Foundation and to the Markle Foundation on the first year of the MIT Research Program on Communications Policy. The Program is a co-operative effort of four research centers at MIT: The Center for Policy Alternatives, The Center for International Studies, The Center for Advanced Engineering Study, and the Electronic Systems Laboratory.

The Program has undertaken several research projects; in the last year we have completed studies on land mobile radio, direct satellite broadcasting, and communications regulation, and have inaugurated new efforts on international data communications and pay TV for the performing arts. The Program also promotes interchange through seminars and publications among specialists who approach communications policy from different perspectives. It brings together electrical engineers, economists, political scientists, and others who share an interest in the decisions that are shaping the communications system of the coming decades.

The major research project, conducted under our National Science Foundation development grant, investigated the economic value of additional spectrum for land mobile radio in cases where there is congestion on the presently assigned frequency bands. This study, undertaken by Robert Crandall and John Ward, arrives at a method for estimating the costs of congestion by taking account of users' willingness to move to higher frequency bands where their costs are higher. The conclusions imply rules that the FCC might adopt in deciding on reallocation of spectrum to or from land mobile uses.

An analysis of the international controversy concerning direct broadcast satellites was undertaken for the Office of Telecommunications Policy and the Department of State by Ithiel de Sola Pool. The findings, which are being published in Foreign Policy, are that both economic and technical factors militate strongly against the imposition of direct telecasting into countries that do not wish to receive it, and that concerns being raised about direct broadcasting are therefore misapplied.

A study of FCC regulatory policy, which constituted the doctoral dissertation of Lawrence McCray, won the E. E. Schattschneider award of the American Political Science Association as the best PhD thesis in the field of American government and politics in 1973. Dr. McCray investigated rules of intervention by economic interest groups in major issues before the FCC Common Carrier Bureau, concluding basically that profit-seeking is a less reliable indicator of group intervention than other factors,

particularly at higher levels of political activism. Dr. McCray is planning to continue this effort with comparative studies of regulatory decision-making in related fields.

Just begun are two additional studies which will be among the main efforts of the Program in the coming year. One of these is an assessment of the social and political implications of dramatic reductions in the costs of global data communications. The other will be an examination of the prospects of funding the performing arts through subscription television or pay CATV; the analysis, comprising both economic and technological subtasks, is being conducted for the Lincoln Center in New York.

During the course of the academic year 1973-1974, the Research Program held a series of 16 seminars on different aspects of communications policy. Attracting an average audience of about 35, these seminars provided a unifying thread for the community of people at MIT interested in communications policy as a public affairs issue.

In addition, a substantial effort was made by the Program to build up international contacts so as to provide a basis for co-operative research in the coming years. We held one meeting at MIT with researchers from England, Europe, Canada, and Japan. We also participated in similar meetings in Canada and England which grew out of the conference at MIT. It is our hope that continuing interaction with colleagues from other countries will add the perspective of alternate national experiences to the study of the way in which societies cope with the problems and opportunities created by the flood of new communications capabilities.

## SUBSTANTIVE FINDINGS

### 1. THE LAND MOBILE STUDY

This study was in two parts: one part by Robert Crandall and John Ward dealt with ways of estimating the value of spectrum for land mobile use. The other part by Lawrence McCray dealt with the land mobile issue as a case study in communications planning.

#### A. The Value of Spectrum in Land Mobile Communications

The value of any resource is measured by the loss of economic product when an increment of the product is withdrawn -- or, alternatively, by the increment to social economic product when another increment of the resource is utilized. The value of the electromagnetic spectrum must be measured in precisely this manner -- by ascertaining the net increment to social value which a marginal increase of spectrum confers in each potential use of the frequency in question.

In land mobile communications, estimating the economic value of spectrum is difficult because of the absence of a price mechanism in transferring rights to particular frequencies and because of the potential for inefficient use which the non-exclusive license creates. "Congestion" is anotner term for uneconomic use of spectrum in which one user places burdens upon others without offering economic compensation. It is often argued that the land mobile radio services -- particularly the business, special industrial, and public safety services -- are excessively congested while the broadcasting services are not. The inference in such a judgment is that spectrum should be transferred to land mobile from broadcasting.

The potential value of additional spectrum in land mobile radio may be assessed by examining the economic benefit of reduced congestion or the potential savings in expenditures by users seeking to avoid the economic consequences of congestion. In practice, there is one major alternative to congestion in the lower land mobile bands -- operation at higher frequencies. As the low and high bands (ranges near 50 MHz and 150 MHz, respectively) have become congested, users have moved to the newer 450 MHz band; those already facing congestion at 450 MHz will seek to operate in the new frequencies allocated by the FCC in the 900 MHz range. Wherever possible, users avoid these

higher bands simply because operation of mobile communications systems at these frequencies is more expensive than at lower frequencies.

Measuring the direct costs of congestion from models of user behavior is very difficult and exceedingly expensive due to the diversity of land mobile use. Plotkin has provided one model of use for the business or special-industrial private dispatch mode which can be utilized for illustrative purposes. Assuming that the average message length is 10 seconds and that maximum loading of 90 mobiles per channels occurs, the annual cost of congestion per channel is between $3,750 and $5,000 per annum. This cost could be avoided in many areas by moving to an uncongested 450 MHz frequency. If we observe 90-mobile loading in a given service when an uncongested channel is available at 450 MHz, we must conclude that the costs of moving to the 450 MHz band are more than $40 to $55 per mobile set per year.

Our estimates of the capital cost of operating at 450 MHz are about 20 percent higher than operation at 150 MHz for the standard private dispatch mode of operation. This translates into a total increment to investment of approximately $175 to $200 per mobile set per year. For very small systems utilizing their own base stations this would be much higher. At a capital charge of 15 percent per year -- the cost of capital plus depreciation -- this translates into no more than $30 per mobile set per year. Thus, in areas where 450 MHz bands are rather uncongested, no new user would utilize a 150 MHz frequency if the congestion costs there were in excess of $30 per mobile set per year. Similarly, existing 150 MHz licensees would shift to 450 MHz over time if congestion costs exceeded $30 per mobile set per year.

The value of extra spectrum at, say, 150 MHz, is thus the reduction in user costs which the increment allows. This savings is measured in terms of either the reduction in the cost of congestion or the reduction in expenditures to avoid congestion. The assumption of rational users allows us to conclude that both measures should be equal. Another potential source of congestion reduction is channel splitting, but this is an option only available when the FCC promulgates new separations rules. Therefore, its potential costs and the contribution which it could make to the reduction in congestion costs must remain conjectural. If it could be shown that reduction of channel widths to, say, 12.5 kHz at 450 MHz would result in costs which are no more than 20 percent above the current capital equipment costs, it should be decreed by the FCC. At present, those users facing congestion in even the 450 MHz band are going to be forced into the new 900 MHz band at which capital costs will be at least 20 percent above their 450 MHz level.

The total value of an additional 25 MHz at each band, low, high, or 450, is easily measured if the alternative to move to the

higher bands without congestion are available. Therefore, in all but the major markets, business and special-industrial channels at 150 MHz may be valued at the product of the number of mobiles times the incremental capital costs for moving to an uncongested 450 MHz channel. For 90 mobile/channel operation, this translates into a maximum estimate of $18,000 per 25 kHz channel as the value of incremental 150 MHz space.

Calculations of the value of each channel in the land mobile service require different assumptions for each service in each geographical location and in each band. Therefore, it is impractical for the FCC to attempt such detailed assessments in their allocations and assignments policies. However, a simple rule could be utilized. If a given service in a given location is not moving to occupy the 450 MHz channels available to it, it must be a reflection of the fact that users in this category in this area are not encountering congestion costs of as much as $30 per mobile set per year in that service in that area. If 450 MHz bands are congested in another service, it is a reflection that congestion costs at 150 MHz are more than $30 per mobile set per year in that latter service. Clearly, channels should be reallocated from the former to the latter.

There is no basis for assessing economic costs of congestion once a means for avoiding it is not open to a user. Thus, in major metropolitan areas, it will be necessary to observe the rate of applications for new 900 MHz channels in order to determine the value of 450 MHz spectrum space which is realized through reduced congestion.

It is important to note that nothing in the analysis of this paper suggests equal channel loading as the proper objective of the FCC. One might observe 450 MHz occupancy for one service when channels at 150 MHz have only 30 mobiles/channel while another service might avoid 450 MHz channels despite much higher 150 MHz loading. This would be a reflection of the much higher costs of congestion in the former than the latter. However, as long as there are unused channels at higher frequencies where capital costs are greater, the FCC can make estimates of the maximum value of lower frequencies. These calculations can then be utilized in long-range planning of future allocations policies circa the lower frequencies. For instance, if there is considerable movement to the 900 MHz band in some services, it will be a reflection of congestion at 450 MHz which costs users at least $30 and perhaps more per mobile per annum. This estimate, multiplied by channel loading at 450 MHz, can be utilized as a basis for comparing the value of another 25 kHz devoted to land mobile as compared to broadcast service.

B. Administrative Planning and its Political Context: The Case of FCC Policy for Land Mobile Radio in the 900 MHz Band

FCC policy-making with respect to the Land Mobile Radio Services is a useful case study for understanding the difficulties of forward planning in the context of heated debate among partisan interests; because it was predominantly an issue of spectrum reallocation, the politics had attributes of a zero-sum game in which a fixed resource was avidly sought by a large number of interests, including representatives from four different industries that are subject to FCC regulation (television broadcasters, land mobile radio licensees, wireline and radio common carriers).

The Case:

The FCC has historically regulated the Land Mobile Radio Services by allocating blocks of frequency channels to specific user categories (police, taxi, motion picture, public utilities, etc.), and relying heavily on user organizations to manage channel assignment and operational discipline among users. This procedure, perhaps the only feasible alternative with available agency resources, appeared adequate for many years, and in fact was able to adopt new technological advances and to augment both the number of eligible user classes and the number of available channels in the more crowded services.

However, by the early 1960's, complaints of congestion multiplied, and land mobile interests claimed that the only meaningful relief was in outright reallocation of frequencies from other services. An unsettled decade of conflict and accommodation followed, featuring special Congressional inquiry, a mammoth industry-supported advisory mechanism, an interbureau FCC staff advisory effort, proposed new rules, shelves of partisan filings, oral hearings, preliminary decision, reconsideration, and, ultimately, pathbreaking new rules.

The new rules, involving reallocation of 115 MHz in the 900 MHz range (including 84 MHz transferred from the upper 14 UHF television channels), represent a significant departure from past policies. About one-third of the new band was set aside for common carrier 'cellular' systems, based on new technology and a different concept of frequency usage which proponents say promises much superior long-term spectrum efficiency (if congestion occurs, the cells are reduced in size, requiring no additional frequencies). Another third was designated for private use under conventional technologies, but was not to be coordinated by user groups; the final third was held in reserve to provide future flexibility in allocation among technologies and services. Innovative new regulations concerning market structure were introduced, and the Commission claimed preemptive jurisdiction from state-level authorities. The Commission stressed that the user was being offered new alternatives among

technologies and suppliers as to how to meet this mobile radio requirements and that in effect some radio uses would be deregulated in the 900 Mhz band.

Conclusions:

1. The Virtues of Administrative Planning

The 900 MHz case indicates that positive planning can occur in the setting of adminstrative law-making, even under conditions of partisan activism and zero-sum payoffs. The FCC decision ultimately was more than merely incremental, and does seem to promise an improved long-term solution for problems of spectrum congestion by taking advantage of newly-developing technologies. The regulatory system was able to anticipate and avert an inevitable crisis, in great part because industry groups' conflicting self-interests worked both to elucidate the problem and to provide stimulus for meaningful reform. Proponents of spectrum allocation through some variety of unregulated market system must acknowledge that the present administrative procedures do achieve self-adjustment through political give and take; while the political-adminstrative system subject to adversary pressures is clearly not ideally efficient, neither is it absolutely static or insensitive to changing needs and technologies.

2. Deficiencies in Planning.

The fact that positive, non-incremental planning did occur, however, is not to say that it was an assured outcome, an unflawed and inevitable product of the politics of regulation. For instance, at three points in the case, developments clearly depended on the actions of individual public officials (a new Commissioner, a maverick Congressman, a new Chief Engineer); had these individuals not been present, it is quite possible that group pressures would have had little ultimate effect. In addition, it required over ten years for the FCC to reach its decision, and it is plausible that the same decision could have been reached in far less time, given a more attentive and decisive Commission. The FCC's handling of the case is also open to the charge that short-term objectives systematically pushed long-term solution to a back burner (in fairness, however, it must be noted that this in part merely reflects Congressional pressure for an immediate solution at the expense of long-term optimality).

One result of the FCC's short-term orientation was inordinate delay in reaching long-term decisions, since the case was phased so that resolution of the short-term issue (involving reallocation of some low UHF television channels near the 450 MHz range) preceded serious consideration of the long-term 900 MHz possibilities. Another consequence was that reliable empirical data (e.g. credible market studies for future mobile telephone

demand) were never developed for some crucial questions; the adversary process in this case did allow non-incremental compromises, but it hardly produced an impressive quality of policy analysis upon which the Commission could base a decision.

Finally, it should be noted that the Commission found it expedient, if not necessary, to stretch the concept of due process in reaching its innovative policy decision. Under the terms of the Adminstrative Procedure Act, proposed rules are to be published in order to permit open debate by interested parties. In this case, however, the ultimate decision bears very little resemblance to the proposed rules, and several key provisions were simply never aired for partisan commentary; the implication may be that due process and administrative planning are mutually incompatible.

3. Implications for Agency Reform

A fairly large number of actual adminstrative reform proposals (e.g. reducing the number of Commissioners, segmenting the FCC into mass communications and telecommunications components, lengthening Commissioners' terms) have been offered to redress various perceived FCC deficiencies, particularly in the area of policy planning and coordination. Reviewing these proposals in the light of the 900 MHz case fails to confirm that any such structural reforms would have had clear salutory effect on the 900 MHz decision. Structural reform, almost always the subject of external reviews of the regulatory agencies, may not be the best available answer for the weaknesses of administrative planning by independent commissions. Review of the 900 MHz case supports the old and obvious view that better policy-making requires the appointment of energetic, open, and analytical policy-makers; whatever the organizational form, there is no substitute for strong personal leadership in policy areas requiring planning. The problem of identifying such individuals is admittedly difficult. However, there is a surprising convergence of opinion among opposing sides as to which past FCC Commissioners have been superior. In general, the major problem is not that merit and expertise yield to party politics in the selection of agency personnel, for many of the most widely respected Commissioners have in fact been former campaign workers. Renewed intellectual activity might productively be directed at the process of Presidential appointment and confirmation.

## 2. THE ELECTRONICS INDUSTRY AND INTERNATIONAL TRADE

This study was done in conjunction with MIT's Research Program in International Business under a contract with the Department of Labor. Analysis was made of trade statistics for radio receivers, television equipment, and telecommunications apparatus in the past decade.

Telephone apparatus and parts has involved minimal foreign trade. Consumer electronics on the other hand showed a regular pattern with extensive world trade. U.S. production has been high in newer, sophisticated technologies. As a product line became better established, foreign competition increased, and U.S. firms responded by off shore production of the (by then) conventional products.

Interviews with representatives of electronics manufacturers who have closed plants in the United States over the last four years reveal factors involving:

1. Reduced U.S. defense purchases.
2. Consolidation of product lines.
3. Consolidation of parts manufacture.
4. Restructuring of the manufacturing operation.

Interviews with representatives of U.S. electronics manufacturers who have opened plants in foreign countries over the last ten years indicate among the factors critical to the decision to manufacture off-shore:

1. They are satisfying off-shore markets principally, and the nature of this business requires close proximity to the customer.

2. The mix of factors of production involves a high labor content, the result of which is that manufacturing economics dictates manufacture in a low labor cost area. While these considerations led to extensive direct investment and production in low cost areas for products involving old, well-established technologies, new products kept appearing in this dynamic field, leading to a growth of the U.S. electronics industry.

## 3. COMPARATIVE RESEARCH ON COMMUNICATIONS POLICY

Most deliberation in the United States on the subject of communications policy has been highly parochial. Despite the fact that every advanced industrial country faces many of the same problems in regard to both their mass media and their telecommunications systems, most American discussions proceed as if the rulings of the FCC and the Supreme Court were the whole of accumulated lore on the subject. Every advanced industrial country faces the problem of supporting high quality cultural materials of interest to small minorities. Every such country faces the problem of restricting material that is harmful to children while otherwise preserving freedom of expression. Every such country is in conflict over the advantages of competition and the advantages of an integrated communications delivery system. Every such country has difficulties getting good technical advice on communications to its political decision makers and in deciding when to scrap its investment in old technologies in favor of new ones. Almost every country has the problem of a deteriorating post office and telegraph system, the spread of TV and radio at the expense of the printed media, the increasing concentration of control of the latter. Yet, even if the problems are similar, the solutions are very different. Countries make different choices as to how to respond to the policy options.

There is thus much that can be learned from comparative examination of the communications policies adopted in the various countries of Europe, Japan, and other nations where the technology of communications is relatively mature. There is also much to be learned from the experience of the developing countries, even though their problems are in many respects fundamentally different. The case is a fortiori stronger for the need to examine comparatively the experience of countries whose problems are much the same.

These considerations have led our program at MIT to initiate contact and co-operative relations with researchers in other countries working in our area of concern. We have taken as one of our primary goals for the immediate future the development of co-operative comparative research to pursue with scholars from other countries. What we have as yet to report is only a set of conferences and conversations. Our objective is to develop research projects in which researchers in different countries would each report on the same problems from the perspective of their country.

Three conferences have been held so far as part of our effort to foster "invisible colleges" of communications researchers on a worldwide basis.

The first meeting was in Montreal on March 8, 1974, chaired by Professor James Taylor of the University of Montreal. Sixteen Canadian scholars from eight universities and from government met to identify areas of interest for comparative research. Professor Pool of the MIT program met with them. A report was prepared listing eleven main topics of common interest, most of which might have appeared in a U.S. document of the same sort: what to do with the TV channel capacity that is coming; information overload; attachments to the common carrier plant; the regulation of the communication industry; and the representation of interest groups. However, one question had top saliency in Canada which would probably not have appeared in a U.S. discussion at all: the problem of the survival of cultural communities. This comprises both the problem that Canadians see of US media dominance, and the problem that French Canadians see of Anglophone dominance.

A second meeting, held at MIT in April, brought together Akira Arikawa of the Research Institute of Telecommunications and Economics in Japan, Nicholas Jéquier of OECD, Alex Reid and Brenda Maddox from England, and three of the participants in the Montreal meeting, together with a dozen American participants. If any one issue dominated the discussion it was the choice between monopoly and competition. How does each, for example, affect the rate of innovation. Is an integrated communication monopoly more willing to accept new technologies than a firm that lives and dies by a single mode of communications delivery, or does a monopoly lack the incentives to innovate. Under what industry structure does each possibility materialize. There was also discussion of how to organize co-operation in research between scholars in different countries so that questions like the above could be explored in different case studies.

From Cambridge the participants proceeded to the Airlie House meeting on telecommunications policy in which all the NSF grantees under the program of which we are a part participated. Professor Pool organized the international session of that meeting, which in effect became a continuation of and broadening of our Cambridge meeting.

The third international meeting to grow out of these efforts at building contacts was held in London in June. At the Airlie House meeting it had been decided that it would be useful to have gatherings in a number of different locations; the London meeting was the first response. The British Post Office took the initiative and acted as host, through the good offices of Alex Reid. We invited the International Broadcasting Institute to join in sponsorship, which it did, helping to organize the meeting; Edward Ploman of IBI was the co-chairman. Professor Pool gave the

opening address dealing with the reasons why research on the social effects of telephony has lagged behind that on the impact of the mass media. The focus of the London meeting was specifically on telecommunications research. Among the half dozen universities represented among the 20 or so participants, several have research centers on mass communication, from which scholars came, but the people they met from the Post Office and industry were mostly individuals whom they had never met with before, and the topics were ones on which there has yet been little academic research.

There were four persons from the US and Europe at the London meeting. The IBI and our Program are working together to stimulate further steps toward comparative and co-operative research. Professor Pool delivered a paper on the subject at the Mexico City meeting of the IBI in August, and he is working with a committee chaired by Asa Briggs, vice Chancellor of the University of Sussex, to start some such studies. A meeting comparable to the London meeting is expected to be held in Paris in February.

While the interest in co-operation on comparative research is very great among students of communications in many countries, the problems of funding for such research are equally great. Ideally, most of the funds in each country should be raised there; the domination of any one funding source may be undesirable. Yet it is extremely difficult to co-ordinate fund raising from sources in different countries. In addition, we must add, the funding for international studies in the United States today is very difficult. Important as an international perspective may seem to us, there are few sources that regard the funding of such research as their domain.

It seems fair to say that the most important and difficult problem for the development of our communications program at MIT is to secure some flexible and long range funding that will make it possible for us to work effectively in co-operation with researchers from other countries on problems of mutual interest. That is the top item on our present agenda.

## THE MIT COMMUNICATIONS POLICY SEMINAR

A successful bi-weekly seminar series served as a focus for the planning and development activities of the Program. Sixteen seminars were held, most of them on subjects pertaining directly to current or projected research at MIT. The sessions attracted listeners from a wide variety of disciplines and professions, serving both to stimulate interest in areas of active research and to assist speakers in refining their thinking through lively discussion with an informed audience.

Attendance averaged about 35 per meeting. Of these, roughly two-thirds were affiliated with MIT, the remainder coming in equal strength from other universities and from nonacademic organizations. Minutes for each presentation were distributed to a mailing list of roughly 300 individuals, half of whom reside outside the Cambridge area. Analysis of this roster reveals interest from several different sectors; 60% represent non-MIT affiliations, including other universities (25%), private enterprises (15%), public service organizations (10%), and governments (10%).

September 26: "Spectrum Management and Land Mobile Radio", presented by Robert Crandall, John Ward, Charles Jackson and Carroll Bowen [all from MIT].

Participants described the proposed work of the land mobile demonstration project and raised issues of spectrum management. Discussion focused on problems associated with spectrum congestion; how a market analysis could be employed to measure the economic value of reduction in congestion; and technical alternatives, such as channel-splitting and cellular systems, to augment efficiency in spectrum allocation.

October 17: "Integration of the National Communcations System", presented by Ithiel de Sola Pool, Carroll Bowen, and Jack Ruina [all from MIT].

This session presented and assessed the principle results of two conferences on integration in communications held at MIT in April 1973 and at Aspen in August 1973. Various facets of integration were discussed: the existence of a single organization with operating authority; shared facilities; systemic planning; and cross-subsidization. A variety of approaches to the issue were addressed: technological, economic, regulatory, and media. The desirability of integration was examined in the contexts of economies of scale, an integrative approach to the regulatory process, and diversity in programming.

October 31: "Current Issues in Telephony", presented by Lawrence McCray [MIT] and Al Stark [AT&T].

Historical background and current status of seven major regulatory issues in common carrier communications were presented. The discussion of interconnection focused the foreign attachments question including the Carterfone decision. The MCI decision and the rise of the specialized service common carriers were reviewed. A third issue concerned tariff provisions relating to the resale or sharing by third parties of services purchased from the carriers. Other policy issues included domestic satellites, two-way CATV, and the provision of bulk rates to large communications users. The question pervading all these issues was the extent to which the telephone companies can be permitted to compete freely as more and more segments of their service monopoly are opened to other entities.

November 14: "Prospects for an International Packet-Switched Data Network", presented by Arthur Corte [MIT], Joseph Markowitz [MIT] and Craig Fields [Harvard].

The convergence of communications satellite technology and the ARPA-developed packet-switched data network could result in orders-of-magnitude reductions in the cost of international data communications. Computer-readable data bases will be increasingly available for remote access. One implication is that developing countries may have an opportunity to leapfrog into the data-oriented modern world if the proper organizational, economic, technological, and political arrangements can be achieved.

November 28: "Future Technology and Policy for the U.S. Postal Service", presented by Joseph Fleming, J. Herbert Hollomon, Charles Jackson, Abraham Tersoff, and Nelson Upthegrove [all from MIT].

The present cost structure, innovation, and operating practices of the U.S. Postal Service were outlined, and comparisons were drawn with telephony and with other delivery services. The Postal Service employs about the same number of personnel (roughly 700,000), has about one-half the annual revenues ($10 billion), and has about one-eighth the capital plant ($400 million) as the telephone industry. Organizational planning and the USPS' R&D program were reviewed, with particular attention being devoted to prospects for "electronic mail"; the dominant fact concerning electronic mail is that while communications costs would be small, the real bottlenecks in sorting and local

delivery would remain even if long-haul transmissions were converted into data communications. Measures of postal effectiveness, the political and social constraints on the system, and MIT research plans on postal systems were discussed.

December 12: "The Economics of Pay Cable", presented by Carroll Bowen [MIT], Robert Crandall [MIT], Martin Ewenstein [CBS], and John Ward [MIT].

Recent experimentation and plans for pay TV were reviewed. Available indirect evidence as to the value that the public attaches to additional channels was adduced. Currently, the level of demand for program diversity is not very encouraging for investment in channels beyond those broadcasting programs for the three networks. Participants assessed as more difficult the task of estimating demand for by-the-program pay television, even assuming successful transition to a high-penetration, interconnected system of CATV services.

January 8: "Issues of Telecommunications Policy", special session presented by Clay T. Whitehead, Director, Office of Telecommunications Policy.

Dr. Whitehead reviewed the major considerations underlying the Cabinet Task Force on Cable Communications. The alternative philosophies on access to the media - the print model of pluralism and the TV model of fairness - were discussed.

January 9: "Future Transmission Technologies", presented by Robert S. Kennedy [MIT], John Fulenwider [GTE Laboratories], and John E. Ward [MIT].

The main subject discussed was fiber optics. The technical characteristics and problems of fiber as a transmission medium were laid out. Optical fibers do not represent a revolutionary new concept: "Light pipes" have been around for years, but have had little utility for communications due to high attenuation losses. Recent advances in reducing attenuation have led many to see fiber optics as a serious competitor with coaxial cable and millimeter waveguide transmission. Major problems ahead are in developing reliable manufacturing processes and development of necessary ancillary devices. Among the major advantages is their small size, and the early uses of optical fiber are likely to be between switching centers where duct space is at a premium. Even though the changes are not as revolutionary as sometimes pictured, the cost reductions are significant.

January 23: "Urban Public Safety Systems", presented by Richard C. Larson [MIT].

The discussion focused in three areas: the operating characteristics of urban public safety systems; research funding, focusing on the NSF/RANN project at the Operations Research Center at MIT on police, fire, and ambulance dispatch systems; and some technological and organizational innovations that have been introduced recently. Police, fire and emergency medical services are among the most labor-intensive, undercapitalized sectors in the U.S. Since labor costs have been steadily increasing, there will be increased pressures to improve productivity through organizational and technological innovation. This involves addressing communications problems of queueing at the dispatcher, automatic location of vehicles, and feedback as to conditions in the field.

February 6: "Issues and Dilemmas in Satellite Communications", presented by John V. Harrington [Comsat].

The technological trend in satellite communications will probably be toward de-emphasis of frequency division multiplexing in favor of time division multiplexing. There will also be greater emphasis on beam switching. The greater complexity of the satellites might mean shorter lifetimes. Saturation in the 4 and 6 GHz frequency bands will drive commerical satellite tramsmission first to the 11 and 14 GHz bands and ultimately to the 20 and 30 GHz bands. These changes will involve investment in new earth station equipment.

February 27: "Appraising the Whitehead Report", presented by Ralph M. Baruch [Viacom International], Richard Jencks [CBS] and Kas Kalba [Harvard].

Among the reactions to the Cabinet cable report were concern that it paid too little attention to how to encourage growth of cable without undue dislocation in the existing media; doubt that the report will have a substantial impact on the industry; and a feeling that the report addressed a fundamental concern - while the role of government is important in developing cable, it must not overcontrol the new medium.

March 1: "The Cable Television Information Center: Past, Present, and Future", presented by W. Bowman Cutter and Edwin A. Deagle, Jr. [both of CTIC].

CTIC is an element of a newly emerging "quasi-public sector" which attempts to take into account the long-range consequences of policy decisions. In the beginning the program was largely oriented toward the day-to-day needs of cities on questions of CATV policy. Emphasis is now shifting toward larger policy questions and may result in the abandonment of the practice of non-advocacy.

April 3: "Consumer Durables", presented by Robert T. Lund, J. Barton DeWolf, and Lewis Erwin (all of MIT).

The group reported the results of a 20 month study of the productivity of servicing consumer durables. Refrigerators and color TV receivers were investigated. Among the findings of the study were great improvements in reliability of the products manufactured over the last several years, resulting in lower life-cycle costs for services delivered. Incentives to manufacturers to improve the reliability of products have become stronger due to the prevalence all-inclusive warranties.

April 24: "Communications Requirements in Telemedicine Systems", presented by Roger G. Mark and Thomas Willemain (both of MIT).

Telemedicine systems are being looked at to provide broad-range medical care and specialty expertise to areas where it doesn't presently exist. A nine month study in Cambridge, however, failed to confirm that TV would result in significantly improved service over telephone communications. One of the findings was that nurses tended to step back and allow greater patient-doctor contact with TV. With the telephone nurses functioned more as primary decision-makers.

May 8: "The Future of Telecommunications", presented by Eugene G. Fubini (E.G. Fubini Associates) and Joseph F. Coates (National Science Foundation).

The possible union of telecommunications and biochemistry was discussed as an example of the cross-fertilization of fields of knowledge. Telecommunications research might tell how information can be coded in forms that the brain can most readily assimilate; artificial intelligence might thus plausibly borrow from neurology. At a different plane, discussion focused on the new industrial revolution - pervasive electronics. Profound changes in solid state and circuit integration technologies have already affected the calculator and mini-computer fields. The future will see such applications as solid state washing machines and flat tubeless pocket television receivers; the aggregate

impact on everyday life will be profound.

May 22: "Privacy Issues in Data, Voice and Video Communications", presented by Jeffrey A. Meldman [MIT].

The concept of a legal right to privacy stems from an 1890 Harvard Law Review article which cited the dangers of photography and the newspaper enterprise, and called for the "right to be let alone". Cable TV relates to a potential invasion of privacy in at least four ways: citizen surveillance, cable tapping, program monitoring, subliminal messages and offensive programming. Design criteria to reduce the dangers of cable-related invasion of privacy were discussed.

## PROGRAM FOR THE SECOND YEAR

### Emerging Research Interests

Interaction among participants in the Research Program gave rise to a number of new suggestions for research. Of these, three have been written up as formal proposals for outside sponsorship, as summarized below. We would expect several others to be delineated during the academic year.

1. International Packet Data Communications

(Professor Pool, Dr. Markowitz, Mr. Corte)

Rapidly changing technologies for intercontinental transmission and data handling are producing new possibilities for international data communications. This project will examine the technical, economic, and organizational/political implications of the emergence of low-cost, distance-insensitive, packet-switched data communications, which could provide users in both developed and developing areas with immediate worldwide access to centrally-maintained data bases.

2. Prospects for a Lincoln Center Pay Television System

(Professor Crandall, Mr. Ward)

This project addresses the design of a technically feasible and economically viable form of pay television (either cable or off-the-air) to distribute events produced at the Lincoln Center, New York, to the nation's households. Economic considerations include analysis of costs of alternative technologies and assessment of demand for cultural programs. Technical aspects include evaluation of various technological options for delivery, including control of channel access and provision of high quality (15 kHz) stereo audio.

3. Cross-national Study of Communications Policy

The major issues of communications policy in the United States are generally common to all industrialized countries; among them are the choice between regulation and laissez-faire, between public monopoly and open competition, and between local and national media programming. The research objective is a systematic comparison of the causes and consequences of international variations in communications policies.

## Publications and Reprints

In its second year, the Program will initiate publication of papers and monographs, including research results from the first year's work. Reports for the Program's seminars and reprints of material released earlier will also be disseminated.

## COGNATE ACTIVITIES

The activities described above have been largely supported by NSF and Markle grants. These grants helped expand an already existing set of interests among the community of scholars constituting our research program. We here briefly note some of their cognate activities.

1. Direct Satellite Broadcasting:

Professor Ithiel Pool prepared a paper for OTP on that subject, and a second paper for a State Department advisory meeting in February. They have been submitted for journal publication.

2. Communications and Development:

Professor Frederick Frey has written the chapter on this subject in the new Handbook of Communications. Professors George Mathjens and Jack Ruina, together with Robert Butman of Lincoln Laboratory and graduate students Colin Warren and Andre Colpitts, are continuing their AID project on the role of telecommunications in development. They have paid particular attention to telecommunications in educational programs and to the uses of satellites. During the summer of 1973, Professor Pool lectured for USIA in Tanzania, Kenya and Ethiopia on the communications revolution. During the spring semester Professor Daniel Lerner is on leave at the East-West Center at the University of Hawaii, working with Professor Wilbur Schramm on communications in Asia.

3. The Audience for Public Broadcasting:

Mrs. Karen Sapolsky is directing the Boston area audience research for CPB. Professor Ithiel Pool is on the Corporation's advisory board for audience research. The CPB research plan was designed by him in a report to the Ford Foundation.

4. CATV:

Professor Frank Reintjes is a member of the Massachusetts State Cable Commission. Carroll Bowen and John Ward were on the program of the Dallas meeting on Cable Television and the University. Professor Pool was one of the commentators on the Cabinet Task Force Report on Cable Communications at the Aspen conference at the time of its release. John Ward, Frank Reintjes, Carroll Bowen, Lovell Dyett, and Ithiel Pool served as advisors to the City of Boston in its CATV

planning. John Ward and Professor Frank Heintjes participated as members of panel "Patches of Blue" at the New England Cable Television Association Convention, July 10-12, 1974, Bretton Woods, N.H. (transcripts available from NECTA).

5. Cable Data:

Dr. Alan Kessler has organized a prototype Massachusetts cable data information system using the Admins data management system developed by Stuart McIntosh and David Griffel.

6. News Study Group:

Under the guidance of Edwin Diamond, this group of students has undertaken research and analysis of media coverage of national and international events. Specifically, in the past year, it has worked on Congressional campaigns and Congressional hearings. Planned is research of the recent Middle East conflict from Arab, Israeli, and American media viewpoints and the movement of information in crises (Boston busing, the economy, and other "crisis news").

7. Optical Communications:

Professors Robert Kennedy and Jeffrey Shapiro are concerned with determining the fundamental limitation upon the performance of optical communication systems; the extent to which these limitations suggest the possibility of improved system performance; and the means of realizing this improvement in practical systems.

8. Data Networks:

The Electronic Systems Laboratory, under its new director, Professor Michael Athans, will be devoting a major effort to research on communications networks. One project, directed by Richard Marcus, concerns compatible access to diverse data bases on a network.

9. Regulation:

Professor Paul MacAvoy has been responsible for the development of an expanding research and teaching program in the Sloan School of Management on governmental regulation of business activity.

10. Technology Management:

At the Center for Policy Alternatives, Herbert Hollomon and Thomas Allen direct a five country comparative study on technology and innovation. At this stage of the project,

they have descriptions of government policies designed to encourage technology in various industries, including the communications industry, in Germany, Netherlands, the United Kingdom, France, and Japan, as well as a comprehensive comparative bibliography on policies for technology.

11. Communications and Society:

Professor Ithiel de Sola Pool participated in Aspen Institute meetings on communications and society in Aspen and Berlin.

12. Communications and Arms Control Policy:

Professor Ithiel de Sola Pool participated in ACDA meetings on the relationship between communications and arms control policy held in Washington and Aspen.

13. Comparative Communications Research:

Professor Ithiel de Sola Pool delivered a paper on comparative communications research at an International Broadcast Institute meeting in Mexico City in August 1974. He conducted discussions in Stockholm with Swedish Telephone Co., L. M. Ericsson Co., and university scholars on comparative research.

14. Advisory Activities:

Professor Robert Fano has served on the scientific advisory committee of the Office of Telecommunications in the Department of Commerce. Professor Fernando Corbato has succeeded him.

Carroll Bowen served as consultant in instructional technologies at Swarthmore College and Penn State. He attended a planning meeting held in November by the FCC. He serves as a communications consultant to the Graduate School of Library Science at the University of Illinois and to the American Association for the Advancement of Science. He is permanent advisor in instructional technology at the University of Pennsylvania and gave a paper entitled "Telecommunications and Future Libraries" at the National Conference of Libraries and Information in Boston in October, 1973.

John Ward serves on the FCC's C-TAC Panel 5 on Frequency Channeling Plans for Cable Television, the IEEE Frequency Allocation subcommittee, Coordinating Committee for Cable Communication Systems; and on the Lexington, Mass. Advisory Committee on Cable Television where he is Chairman of its Systems Subcommittee.

Professor Ithiel de Sola Pool served on the organizing committee for the April 1974 Airlie House meeting on Communications Policy. He was elected a trustee of International Broadcast Institute. He serves on the Systems Modelling Advisory Committee to the Office of Technology Assessment of Congress, dealing, among other things, with communications and rural society. He consults for ACDA on the relationship between communications and arms control policy.

Edwin Diamond is commentator for Post-Newsweek stations in Washington, and a contributing editor of New York magazine.

Professor Jack Ruina served on the National Academy of Engineering Panel on Telecommunications Research which last June issued the report, "Telecommunications Research in the U.S. and Select Foreign countries".

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## PROGRAM PERSONNEL

Funding from the National Science Foundation and Markle Foundation has provided full or partial support for the work of the following MIT staff members:

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